LESSON 3

Basic Soil Properties for Foundation Design

BASIC SOIL PROPERTIES FOR FOUNDATION DESIGN

Lesson 3

Slide 3-1

Prior to beginning the lesson, recap the site exploration

BASIC SOIL PROPERTIES FOR FOUNDATION DESIGN

1. List Main Soil Groups and Basic Engineering Uses

2. Differentiate between Identification, Description and Classification

ACTIVITIES: ***Soil Description***
Local Lab Tour
Geo-Quiz

Slide 3-2

How would you define soil; and write the audience response on a flip chart.

Definition of Soil

Naturally occurring mineral particles which are fairly readily separated into relatively small pieces and in which the mass may contain air, water, or organic materials.

Mineral particles of the soil mass are formed from decomposition of the rock by weathering (by air, ice, wind and water) and chemical processes.

Slide 3-3

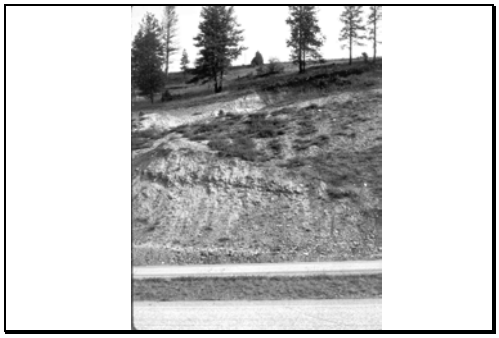
Read definition slowly.

Focus on the points that these particles are hard and do not easily deform.

Also stress the importance of area geology in determining types of soil, which may exist.

Slide 3-4

Explain how the glacier at Portage Alaska creates soil from rock. First point out the valley glacial in the upper left and describe how the ice mass is moving downward and scouring rock from the valley wall. Then point out the material is carried into the plain by the ice and joins other valley glaciers. The soil material (shown in this picture by the dark strips in the ice) is carried to the glacier terminus where the ice melts and the soil is deposited.



Slide 3-5

Explain transported versus residual soil deposits.

Slide 3-6

Stress that laws of soil mechanics do not apply to manmade materials such as dumps and that special treatment must be considered for such situations.

Emphasize that we will only deal with simple soils in this class.

Main Soil Groups

- ***Granular Soils***
  - ***Sands and Gravels***
- ***Fine-Grained Soils***
  - ***Silts and Clays***
- ***Organic Soils***
  - ***Organic Silts and Clays, Peats, Mucks***

Slide 3-7

Introduce the soil groups which will be discussed in this lesson.

Granular Soils

Sands and Gravels

Slide 3-8

Introduce granular soils. Mention that we are starting with the most useful soil group.

Slide 3-9

Ask how you would know from the picture that these are granular soils. The answer is that we can discern individual particle sizes with unaided eye.

Identify by Grain Size

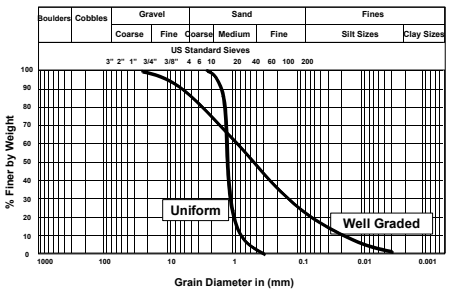
Slide 3-10

Granular soil types are identified by their grain size. Soil classification systems define the range of grain sizes for both gravel and sand particles. The smallest sand particle is just within the range of vision for the average person.

Gradation Test

Slide 3-11

Describe gradation test process and how each sieve size has standard openings in the mesh. Mention that the distribution of grain sizes in a soil sample affects the engineering properties of the mass.



Slide 3-12

Explain how gradation test results are shown and interpreted. Only discuss properties of long graded and uniform graded. Name some engineering uses for the well-graded and uniform graded soils shown in the gradation plot. Focus particularly on density and drainage properties.

Engineering Properties of Granular Soils

- ***Excellent Foundation Material***
- ***The Best Embankment Material***
- ***The Best Backfill Material***
- ***Possibly Susceptible to Vibratory Forces***
- ***Dewatering is Quite Difficult***
- ***Not Frost Susceptible if Free Draining***

Slide 3-13

Discuss engineering properties.

Fine-Grained Soils

Soil Mineral Types Control Behavior of Silts and Clays More Than Grain Size

Slide 3-14

Introduce fine grained soils. Mentioned that these particle sizes of silt and clay cannot be seen by the unaided eye. The behavior of a mass of such microscopic particles will influenced by particle attraction, adhesion, and the ability of the parent mineral to attract water. The smaller the particle size the greater the influence of the mineral type.

Cohesive Soils (Clays)

Strength Largely Derived From Cohesion

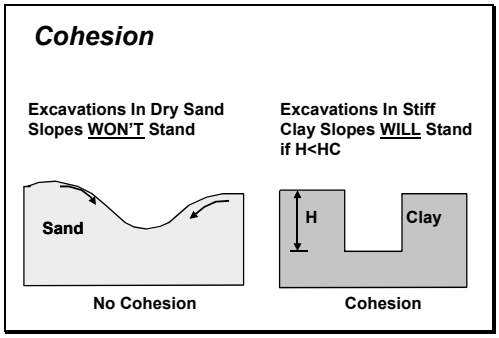
Slide 3-15

Describe cohesive bonding of microscopic soil mineral particles.

Slide 3-16

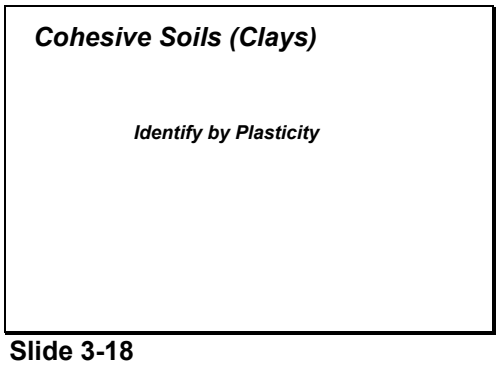
How would you know that this is a clay soil?

Show clay failure. Note how clay stands vertically due to cohesion.



Slide 3-17

Contrast clay and sand properties.

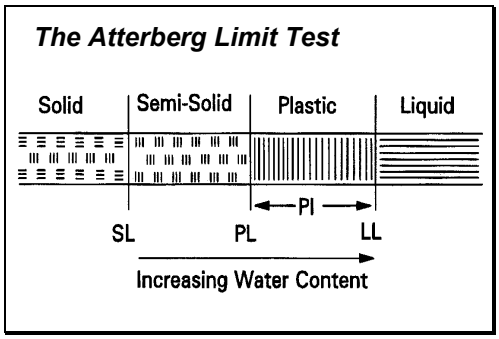


Slide 3-18

Identification of clay soils is done by observing the plastic behavior of the soil mass when manipulated. The relative degree to which a soil can be molded reflects the degree of plasticity of the soil mass.

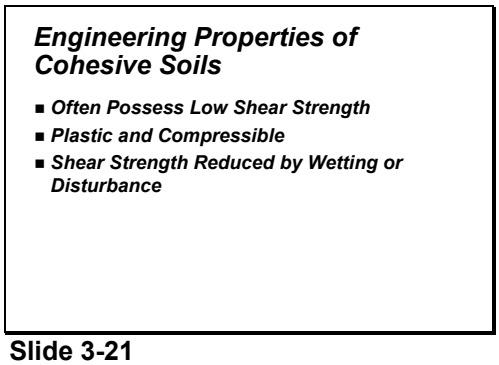
Slide 3-19

Explain that plasticity is easier to show than describe. Note this sample was cut and stretched without cracking or rupture.



Slide 3-20

The physical state of a soil can vary between a solid and a liquid depending on the amount of water the sample contains. The plastic state of a soil is of most interest to the geotechnical engineer as the degree of plasticity has profound effects on the strength and consolidation characteristics of the soil. Plasticity can be easily determined in the lab by a test called the Atterberg limit test. This test will be discussed further in the lab session.



Slide 3-21

List engineering properties of clay. Provide comments on the use of this soil type by the highway agency.

Engineering Properties of Cohesive Soils (Cont'd)

- ***Shrink- Swell Potential***
- ***Poor Material for Backfill or Embankments***
- ***Practically Impervious***
- ***Clay Slopes Prone to Landslides***

Slide 3-22

Continued

Silts

Similar to Clays but Exhibit No Cohesion

Slide 3-23

Introduce silts. Mention that the average silt particle size is much larger than a clay particle. Therefore silt particle behavior is less affected by particle attraction and less water thickness can be bonded by the particles.

Slide 3-24

Show how silts are sensitive to vibration; particularly when the water table is near.

Differences Between Silts and Clays

- *Air-Dried Strength*
- *Appearance When Shaken*
- *Roll into Thin Threads*

Slide 3-25

Show practical ways to differentiate the behavior of silt from clay. Mention that the "shaking" test will be used in the lab exercise to identify silt behavior.

Engineering Properties of Silts

- *Relatively Low Shear Strength*
- *High Capillarity and Frost Susceptibility*
- *Relatively Low Permeability*

Slide 3-26

List engineering properties of silt. Provide comments as to the use of this material by the highway agency.

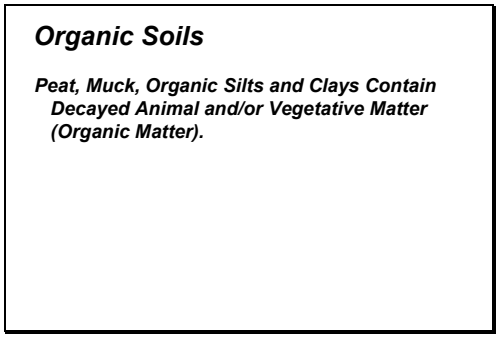
Engineering Properties of Silts Compared to Clays

Silts Characteristically Have:

- *Better Load Sustaining Qualities*
- *Less Compressibility*
- *More Permeability*
- *Less Volume Change*

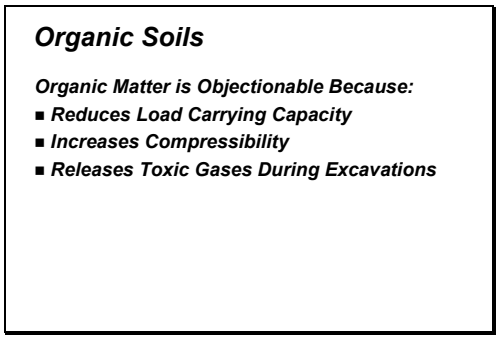
Slide 3-27

Contrast silt and clay properties



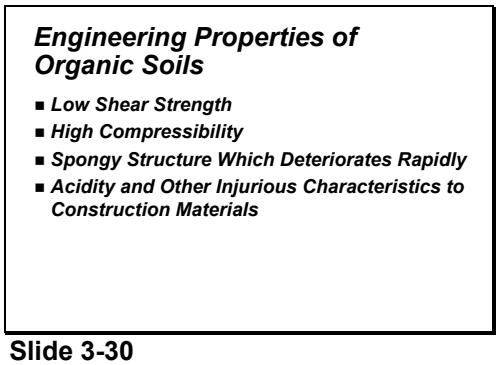
Slide 3-28

Introduce organic soils. Mention that organic materials are found in both residual and transported soils. An important point to remember is that organic material can absorb up to 10 times it's dry weight in water. A small amount of organic can radically change the properties of a soil mass.



Slide 3-29

Warn students that organics are problem soils.



Slide 3-30

Summarize the engineering properties with emphasis on corrosivity.

Slide 3-31

Funny slide. This is where organic originates.

Soil Classification and Description

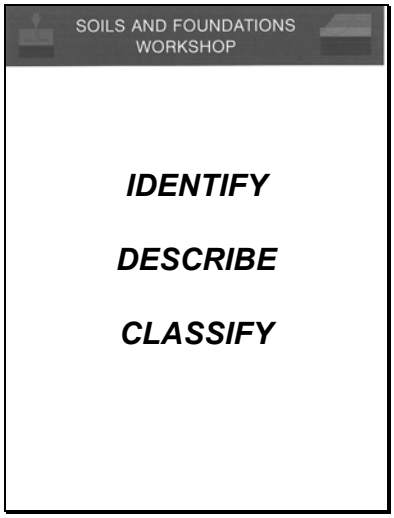
- ***Arrangement of Different Soils into Groups Having Similar Engineering Properties***
- ***Systems Most Used by Highway Agencies:***
  - ***AASHTO***
  - ***Unified***
  - ***ASTM***

Slide 3-32

Explain concept of classification and description in relation to how geotechnical engineers communicate soil properties to each other. (It is a type of engineering language)

Slide 3-33

Mention that we will shortly go into the lab and get our hands dirty. Encourage the group not be afraid to handle the soils in the lab as soil should be treated as any other engineering material.



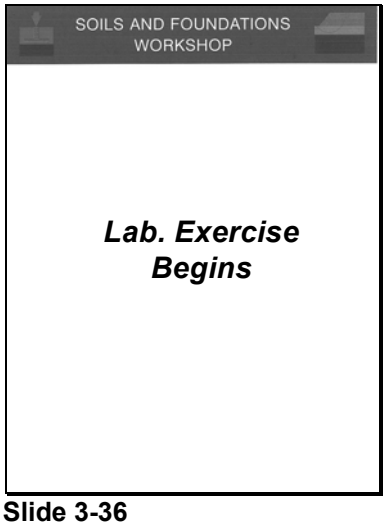
Slide 3-34

Define each term (identify …soil types; describe. estimate relative percentage of each type; classify. test each soil type) and place on flip chart. Explain that we cannot afford to classify every soil sample so we need to train people to accurately identify and describe soils.

Students are referred to the reference manual and important information highlighted in Chapter 3 and in Appendix A that contains "MUD". Instructor uses a blank overhead to illustrate the "MUD" process that will be used in the lab exercise. The focus is on primary component, secondary component, color, plasticity, and moisture condition when visualized. Put the students in the position of a new lab technician who will be trained to describe soils.

Slide 3-35

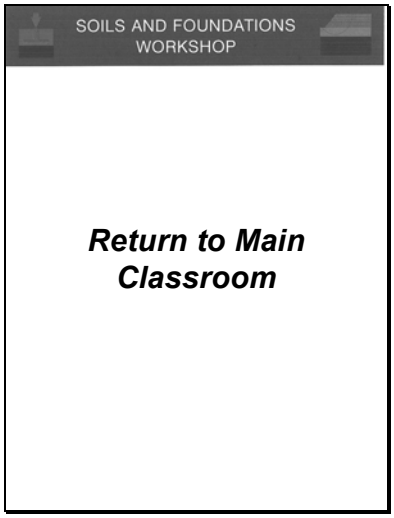
Before leaving for lab, ask student to list the lab tests that are performed in the agency lab.
Write answers on a flip chart.



Slide 3-36

Go to lab for soil description exercise and for tour of lab.

During lab exercise, ask student to describe the engineering uses of all the soils used in the exercise. Prior to beginning the lab tour encourage the students to ask questions. Be prepared to ask "icebreaker" questions to foster interaction between the lab staff and the students. Typically about 1:30 hours for exercise and tour. At the end of the exercise, acknowledge the assistance of the agency lab staff and encourage the students to take advantage of the lab services on future projects.



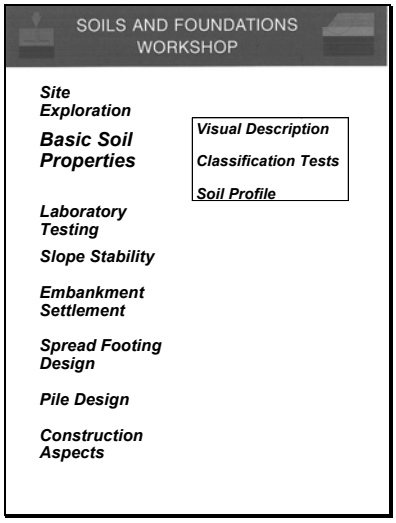
Slide 3-37

On return to classroom, ask students to add to lab test list based on what was observed in the lab visit.

Then give Geo-quiz.

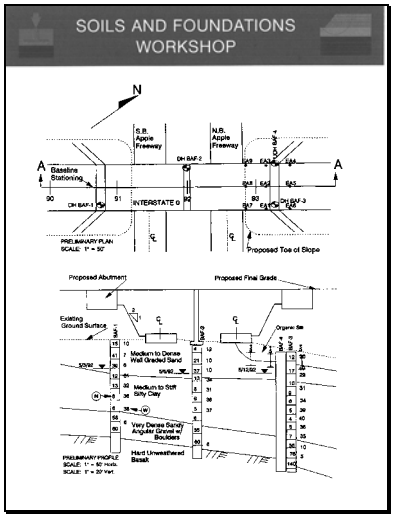
Slide 3-38

Geoquiz Slide is animated such that no answers are shown until left click is depressed sequentially.



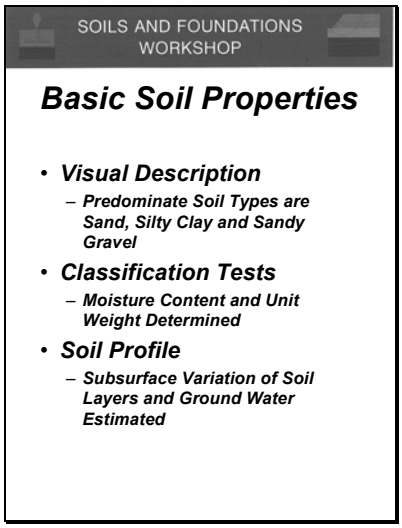
Slide 3-39

After the Geo-quiz, ask the students open the reference manual to highlight the remaining information in Chapter 3 and to begin the Apple Freeway. Show summary to build on site exploration information from previous section. Note we are still in the data collection phases of the project.



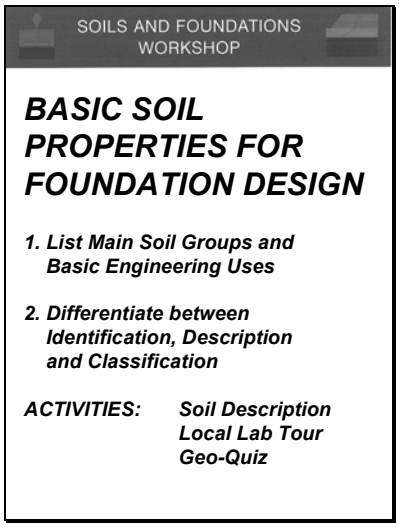
Slide 3-40

Ask group what information was used to develop the soils profile. The answer is the combined results of the terrain reconnaissance, site inspection, and soil/water data from the subsurface logs.



Slide 3-41

Summarize what was done in this segment of the Apple Freeway.



Slide 3-42

Review the initial objectives of this lesson.